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Revisiting Panda 100, the first archaeological chimpanzee nut-cracking site

T. Proffitt [a,*], M. Haslam [b], J.F. Mercader [c], C. Boesch [d], L.V. Luncz [e]

[a] Institute of Archaeology, University College London, 31-34 Gordon Square, London, WC1H 0PY, United Kingdom
[b] Independent Researcher, Putney Bridge Road, London, SW15 2PA, United Kingdom
[c] Department of Anthropology and Archaeology, University of Calgary, 2500 University Dr., NW Calgary, Alberta T2N 1N4, Canada
[d] Department of Primatology, Max Plank Institute for Evolutionary Anthropology, Deutscher Platz 6, D-04103 Leipzig, Germany
[e] Institute of Cognitive and Evolutionary Anthropology, University of Oxford, 64 Banbury Road, OX2 6PN, Oxford, UK

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ABSTRACT

Archaeological recovery of chimpanzee *Panda oleosa* nut cracking tools at the Panda 100 (P100) and Noulo sites in the Taï Forest, Côte d'Ivoire, showed that this behavior is over 4000 years old, making it the oldest known evidence of non-human tool use. In 2002, the first report on the lithic material from P100 was directly compared to early hominin stone tools, highlighting their similarities and proposing the name 'Pandan' for the chimpanzee material. Here we present an expanded and comprehensive technological, microscopic, and refit analysis of the late twentieth century lithic assemblage from P100. Our re-analysis provides new data and perspectives on the applicability of chimpanzee nut cracking tools to our understanding of the percussive behaviors of early hominins. We identify several new refit sets, including the longest (>17 m) hammerstone transport seen in the chimpanzee archaeological record. We provide detailed evidence of the fragmentation sequences of *Panda* nut hammerstones, and characterize the percussive damage on fragmented material from P100. Finally, we emphasize that the chimpanzee lithic archaeological record is dynamic, with the preservation of actual hammerstones being rare, and the preservation of small broken pieces more common. P100 – the first archaeological chimpanzee nut cracking lithic assemblage – provides a valuable comparative sample by which to identify past chimpanzee behavior elsewhere, as well as similar hominin percussive behavior in the Early Stone Age.

1. Introduction

Discussions of the evolution of tool use have historically centered on the hominin lineage: *Homo sapiens* and our ancestors since we split from the other apes (Leakey, 1971; Harmand et al., 2015). Hominin technological evolution is recorded in a durable record of stone tools, which provide detailed information about our cultural and cognitive development, extending back more than 3.3 million years (Harmand et al., 2015). In contrast, our understanding of the technological evolution of non-human primates is in its infancy. The emerging field of primate archaeology addresses this imbalance using modern archaeological techniques to understand the emergence and development of primate tool use, and to provide new comparative insights into the emergence of hominin lithic technology (Haslam, 2012; Haslam et al., 2017).

Owing to their close relatedness to humans, and their propensity to use a variety of tools, chimpanzees received the earliest and most intense attention as a potential model species for understanding early hominin stone tool use. Some West African chimpanzees (*Pan troglodytes verus*) use stone tools in the wild, to crack open different nut species. Two long-term study sites – Bossou in Guinea and the Taï National Park in Côte d'Ivoire – provide the majority of the research data on this behavior. In the Taï National Park, chimpanzees crack open five different nut species (*Panda oleosa, Parinari excelsa, Saccoglottis gabonensis, Coula edulis,* and *Detarium senegalensis*). To crack open the very hard *P. oleosa* nuts, chimpanzees use stone tools that vary in weight between 3 and 15 kg (Boesch and Boesch, 1984a), and mostly use tree roots for anvils. The uneven distribution of stone material throughout the forest means that chimpanzees need to transport hammerstones to *Panda* nut trees to use as tools (Boesch and Boesch, 1984a; Luncz

* Corresponding author.
E-mail address: t.proffitt@ucl.ac.uk (T. Proffitt).

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et al., 2016). Conversely, the chimpanzees at Bossou do not crack *P. oleosa*, and instead primarily use lighter and smaller stone hammers and anvils to open the softer palm oil nut (*Elaeis guineensis*). Additional regional differences in the stone tool use between these two groups consist of the frequent use of transportable stone anvils and the rare reported use of stabilizing stones at Bossou (Carvalho et al., 2009).

In 2002, Mercader et al. published a pioneering study from the Taï Forest proving that inactive chimpanzee nut-cracking sites are identifiable in the archaeological record. For the first time, researchers demonstrated that a primate material record existed and could be traced, using archaeological techniques, into antiquity. In addition, Mercader et al. (2002) suggested that the chimpanzee artefactual record uncovered at their research site Panda 100 (P100) mimicked early hominin lithic technology. They compared the chimpanzee material with some Oldowan assemblages in terms of artefact densities, size ranges and general morphologies of flakes (Mercader et al., 2002). Specific attention was paid to its apparent similarities to Early Stone Age (ESA) lithic assemblages from Omo 123 (Chavaillon, 1970, 1976; de la Torre, 2004), the Shungura formation (FtJi1) (Merrick et al., 1973; Merrick and Merrick, 1976) and KBS Member (Koobi Fora, Kenya) (Isaac, 1976). This led to the suggestion that some lithic material from such Oldowan assemblages may derive from nut cracking behavior, or the processing of other hard-object foods. This first chimpanzee excavation contributed directly to the emergence of primate archaeology as a new discipline, combining both archaeological techniques and primate behavioral observations (Haslam et al., 2009, 2016a, 2016b, 2017; Visalberghi et al., 2013; Luncz et al., 2015; Proffitt et al., 2016). Here, we apply the latest primate archaeological methods to the P100 lithic assemblage, providing new insights into the relevance of this material for interpreting hominin behavior (Haslam, 2012).

2. Background

The P100 site was a known modern chimpanzee nut cracking location. The 100 square meter excavation at the site yielded a substantial artefactual record, including both lithics and organic remains in the form of abundant nut shells and wooden anvils. This study was joined by subsequent excavations at Noulo and Sacoglotis B, dated to over 4000 years ago, and located within a hundred meters of P100 (Mercader et al., 2007). The stones recovered from P100 were proposed as the 'Pandan' type assemblage, that is, the type assemblage against which future chimpanzee archaeological finds could be assessed (Mercader et al., 2002).

Although not explicitly stating that hominin-like conchoidal flake technology was represented at P100, Mercader et al. identified numerous pieces that they classified as 'flakes' within the assemblage, noting that 'panins may have been capable of producing assemblages that mimic some of the earliest hominin artifacts' (Mercader et al., 2002, p. 1455). The apparent similarity of the P100 lithic assemblage to Oldowan hominin stone tool technology has been discussed and contested by a number of researchers (de la Torre, 2004; Delagnes and Roche, 2005; Pelegrin, 2005; Schick and Toth, 2006; Harmand et al., 2015). They suggest that the intentionality and the 'know-how' associated with flake production is only clear in hominin lithic material (Pelegrin, 2005), including an understanding of conchoidal fracture. A recent re-analysis of the Omo Oldowan lithic assemblages has argued for the presence of relatively structured exploitation strategies there, including the structured production of fully conchoidal flakes (de la Torre, 2004). Both the quality and diminutive dimensions of the available raw material at Omo were a major factor in the apparently simple nature of the assemblages. De la Torre (2004) found that any similarity to the P100 lithic material was only in terms of dimensions. The lithic material produced by early hominins appeared qualitatively different to that identified at P100, and indeed to captive primate knapped artefacts (Delagnes and Roche, 2005; Pelegrin, 2005; Schick and Toth, 2006). Hominins showed intentional flake production through the application of consistent technical rules (Delagnes and Roche, 2005), which were detached with a high degree of precision and manual dexterity (de la Torre, 2004). These flakes possessed clear bulbs of percussion, striking platforms, dorsal flake scars and cores with impact points and flake negatives (Schick and Toth, 2006). Even when considering the earliest instances of hominin lithic technology, the Lomekwian (Harmand et al., 2015), the flakes produced are significantly larger than those reported by Mercader et al. (2002). Furthermore, even though it has been suggested that the Lomekwian is closer, in terms of technique, to primate nut cracking, the Lomekwian material indicates that hominins possessed the ability to intentionally strike cores with adequate accuracy and force to detach multiple flakes (Harmand et al., 2015).

The importance of percussive activities involving both an active hammerstone and a passive anvil has recently been highlighted in the human archaeological record at Olduvai (Mora and de la Torre, 2005; de la Torre et al., 2013; Arroyo and de la Torre, 2017), West Turkana (Harmand et al., 2015; Lewis and Harmand, 2016), and Gesher Benot Yaqov (Goren-Inbar et al., 2002, 2015). As the motions involved are similar, this technology may be a better candidate for hominin and chimpanzee comparative studies (de la Torre, 2010; Arroyo, 2015).

Research into percussive technology has focused on the Plio-Pleistocene archaeological record, particularly in East Africa, where percussive behaviors played an important role in the subsistence strategies of early hominins (de la Torre and Mora, 2005; Mora and de la Torre, 2005). To identify this type of behavior, a number of studies have developed referential datasets that characterize the archaeological signature of percussive activities (de la Torre et al., 2013; Caruana et al., 2014; Arroyo, 2015). These studies have either experimentally replicated percussion on the same raw materials identified in the archaeological record (de la Torre et al., 2013; Arroyo, 2015; Arroyo et al., 2016), or quantified the wear patterns associated with intentional percussive activities verses natural taphonomic damage (Caruana et al., 2014). For example, de la Torre et al. (2013) found that experimental activities such as nut cracking, bipolar knapping, meat tenderizing and plant processing produced a range of use-damage on the passive hammer (anvil) involved in the behavior. This damage included archaeologically identifiable detached pieces, corresponding with typical percussive anvil products identified in the archaeological record (de la Torre and Mora, 2005). More recently, the importance of primate percussive technology and behaviors for interpreting the hominin archaeological record has been highlighted using GIS analytical techniques on tools used in field experiments (Luncz et al., 2016) as well as microscopic characterization of percussive damage by captive and wild chimpanzees (Benito-Calvo et al., 2015; Arroyo et al., 2016).

Beyond chimpanzees, recent research with other tool-using primates provides insights into the emergence of hominin flake technology. For example, wild bearded capuchin monkeys in Serra da Capivara National Park (SCNP), Brazil, intentionally strike quartz cobbles together, possibly to obtain trace nutrients. By doing so, they unintentionally produced numerous fully conchoidal flakes (Proffitt et al., 2016), which were not subsequently used. The flakes, resulting from the only recorded behavior where wild primates deliberately strike stone tools on other stones, exhibit the same range of technological attributes commonly identified in hominin flaked assemblages. The identification of such artefacts in the primate record has relevance to the suggestion that hominin flaked

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